

ber in sixty-three years and at Manitowoc in forty-one years. Lack of moisture caused winter wheat and rye to make slow growth, but the plants were healthy and in good condition to withstand the winter.—W. M. Wilson.

Wyoming.—The weather for the month was unusually mild, and pre-

cipitation unusually light. Conditions were extremely favorable for stock interests, except that the absence of snowfall prevented many flocks from being pastured on winter ranges. The ranges of the State were in good condition and stock was keeping fat.—W. S. Palmer.

SPECIAL ARTICLES.

RECENT PAPERS BEARING ON METEOROLOGY.

Mr. H. H. KIMBALL, Librarian and Climatologist.

The subjoined titles have been selected from the contents of the periodicals and serials recently received in the Library of the Weather Bureau. The titles selected are of papers or other communications bearing on meteorology or cognate branches of science. This is not a complete index of the meteorological contents of all the journals from which it has been compiled; it shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau. Unsigned articles are indicated by a —.

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— Relations between solar and terrestrial phenomena. [Note on paper of H. I. Jensen.] Pp. 158-159.

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Ward, R. DeC. Cyclones of the far east. [Note on work of José Algué.] Pp. 810-811.

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Ward, R. DeC. Temperature in cyclones and anticyclones. [Note on work of A. Lawrence Rotch.] Pp. 890-891.

Ward, R. DeC. Cyclonic distribution of rainfall. [Note on paper of H. R. Mill.] P. 891.

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AIRY'S THEORY OF THE RAINBOW.

By Rev. D. HAMMER, S. J., Canisius College, Buffalo, N. Y.

[Reprinted from Journal of the Franklin Institute, November, 1903.]

Up to some seventy years ago Descartes's view of the formation of the rainbow was universally accepted. In 1836 the English astronomer Airy published a new theory, but, as it often happens, it found few admirers, some admitting it only for the explanation of the so-called supernumerary bows. Of late years, however, several scholars have endeavored again to draw the attention of scientists to Airy's theory; as prominent among them may be mentioned Messrs. Mascart and Pernter.

Why, then, one might ask, is Airy's theory so little known while that of Descartes is almost universally taught? The reason may be found in the difficult calculations requisite for a full understanding of Airy's theory. If, therefore, the latter can not, to a sufficient degree at least, be brought within the reach of nonexperts in physics and higher mathematics, no one will require of our colleges and text-books to pay much attention to it. But this is not the case. In his "Ein Versuch, der richtigen Theorie des Regenbogens Eingang in die Mittelschulen zu verschaffen," Doctor Pernter succeeded in putting it into such form that it may without difficulty be introduced into high schools and colleges.

In this essay we shall strive for the same end; our material is drawn from Doctor Pernter's writings on this subject.¹

In order to show the differences between the two theories, we first give a short account of that of Descartes.

Fig. 1 represents the formation of the principal rainbow. A bundle of parallel rays strikes the raindrop. The one that passes through the center of the sphere is not deviated from its course, but all the others undergo a change in their former direction, corresponding to the respective angles of incidence. Following up one of them we see that after two refractions and one reflection it makes a certain angle with the line MN, the axis of the rainbow. This angle we call O. If now we take different angles of incidence increasing at a constant rate from 1° to 90° , we find by construction as well as by calculation that the angle O varies unequally, growing larger and larger till, at an angle of incidence of about $59^\circ 24'$, having reached its maximum, it again retrogrades to 0. Near this limit O has its smallest rate of variation; hence, much more light will be accumulated on this spot than at any other place of the illuminated field. It is this crowding together of (say) red rays that enables us to see the red of the rainbow. Now, since every color has its own index of refraction, every color has also its own maximum O. From this consideration it naturally follows that we must always see the well-known seven colors of the rainbow, and that, provided the apparent diameter of the sun be the same, the width of the bow and its colors remain unchanged. The reason is, the index of refraction, on which the calculation depends, is a constant quantity, and the size of the raindrop, the only variable, is disregarded entirely. Hence, the characteristic mark of Descartes's theory is constancy. It is simple in itself and easily understood, but facts prove its insufficiency.

To convince the reader of this assertion, we are to give an accurate description of the rainbow, a task which, though at

¹ "Ein Versuch, der richtigen Theorie des Regenbogens Eingang in die Mittelschulen zu verschaffen," "Neues über den Regenbogen" and "Die Farben des Regenbogens."

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